DUNE opportunity
University of Montreal expertise

J.P. Martin

History, R.J.-A. Levesque Laboratory

Since the early days of the lab (~1968):

- There was a small technical group providing electronics services (3 persons)
  - Setting up of the experimental infrastructure
    - Cabling from the beam lines stations to the counting room
    - Installing new equipment, racks, bins, patch panels
  - Maintenance of the equipment
  - Later on: upgrades to the original DAQ system, new concepts (CAMAC), etc

  - Much later on: New administrative structure : the “Groupe Technologique” with the ability to do contract work for external customers (industry: ANIQ R&D, ANRAD, Hydro Quebec, Photon ETC; laboratories: TRIUMF, Lawrence Livermore Laboratory, C.E.A. Saclay, Korea Basic Science Institute,

  - Now: Supported mainly by an MRS grant

The people (electronics services)

Chen Won Chao, PhD. , Physics
- Main skill : software expert, Linux systems, networks
- Complementary : firmware and imbedded processors in FPGAs

Nikolai Starinski, PhD. , Engineering physics
- Main skill : electronics design (Altium)
- Complementary : mechanical design, firmware (Quartus)

Hongfei Cao, Technician
- Main skill : electronics, protyping
- Replaces Yanik Landry-Ducharme

J.P. Martin, PhD. , Physics
- Main skill : detector instrumentation, low noise electronics, trigger/DAQ
- Complementary : firmware design, (Quartus, Vivado)

Chen Wen Chao

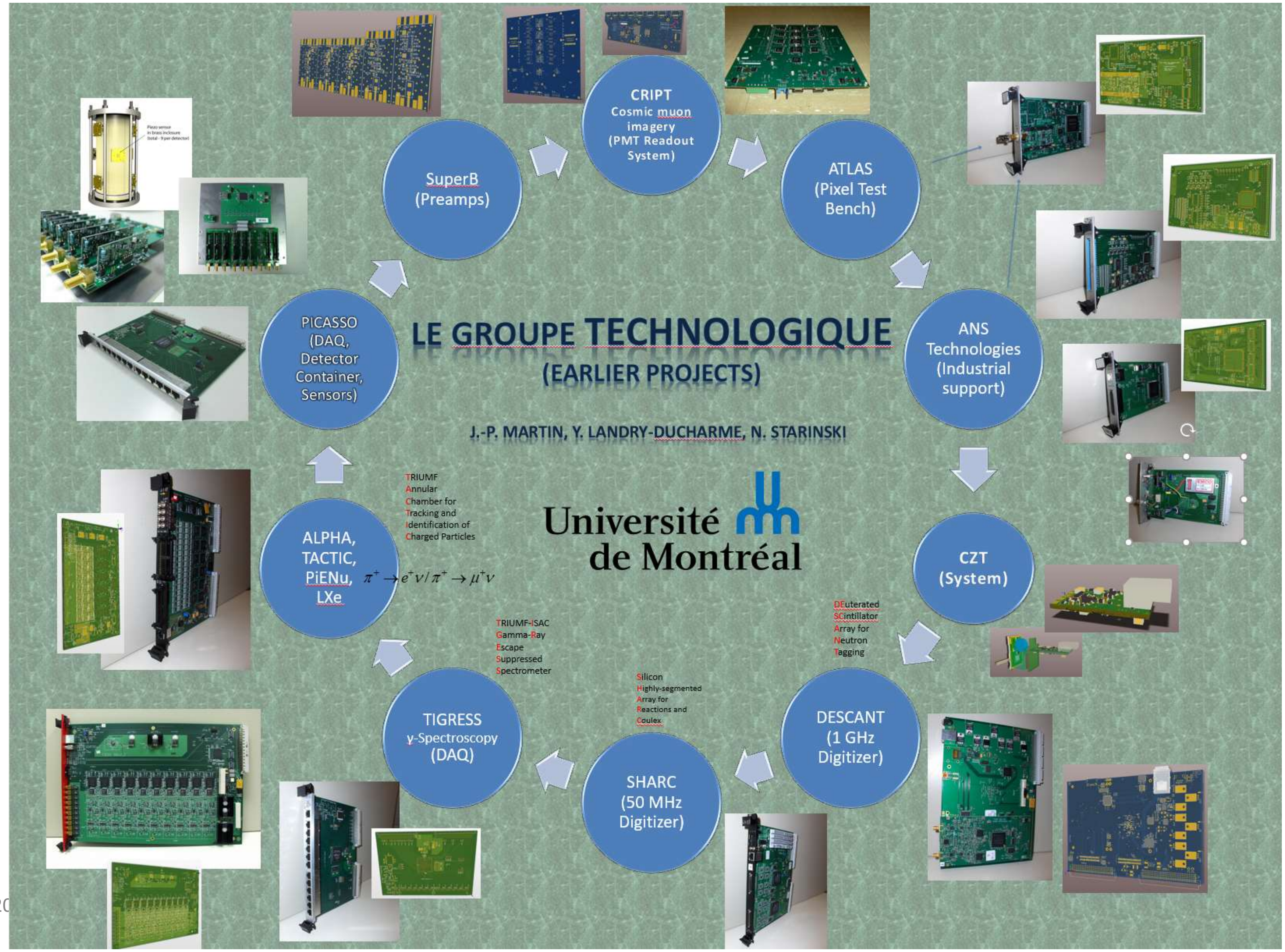
- Computing infrastructure: Computing clusters with CPU and GPU.
- ATLAS ITk Interlock System:
  - Developing tools to test the monitoring system on the PYNQ-Z2 backend. The monitoring system is consist of the backend and the MonFPGA cards.
  - Developing a Monitor OPC-UA server based on Quasar from CERN.
- BELLE II BIRADMON system:
  - Build a MicroBlaze Linux system on a Xilinx Nexys Video board using Petalinux to run EPICS client. The EPICS client sent the collected detectors information to the EPICS database server in KEK.
- PICO-40L : Slow DAQ recording and alarm system for the pressure PLC and temperature PLC.

Nikolai Starinski

- CRIPT project PCB design – 64 channel DAQ board for PMTs with segmented readout.
- Multichannel High-Voltage power supply for SiPMs.
- Fast charge-sensitive preamp PCB for pure CsI crystals and the test setup.
- Radiation Background Monitors for Belle II experiment – design, test and installation.
- High-Speed camera R&D for the bubble dynamics study.
- UV scintillation study for collapsing bubble in the water.
- Plastic Scintillator detectors for the electron-positron calorimetry (X17 project). Electronics and Mechanics. General PMT test setup design for timing and calorimetry.
- Wire Chamber installation and test.
- Preamplifiers for the SiPM tests
- ATLAS Itk
    - Vacuum seal test for the silicon strip detector.
    - Grounding and Shielding properties study for the composite carbon fiber plastic.
    - Interlock Crate design. Power section and backplanes. “Hot swap”/Power Sharing configuration.
    - Setup for the silicon strip hybrid detector readout test.

J.P. Martin

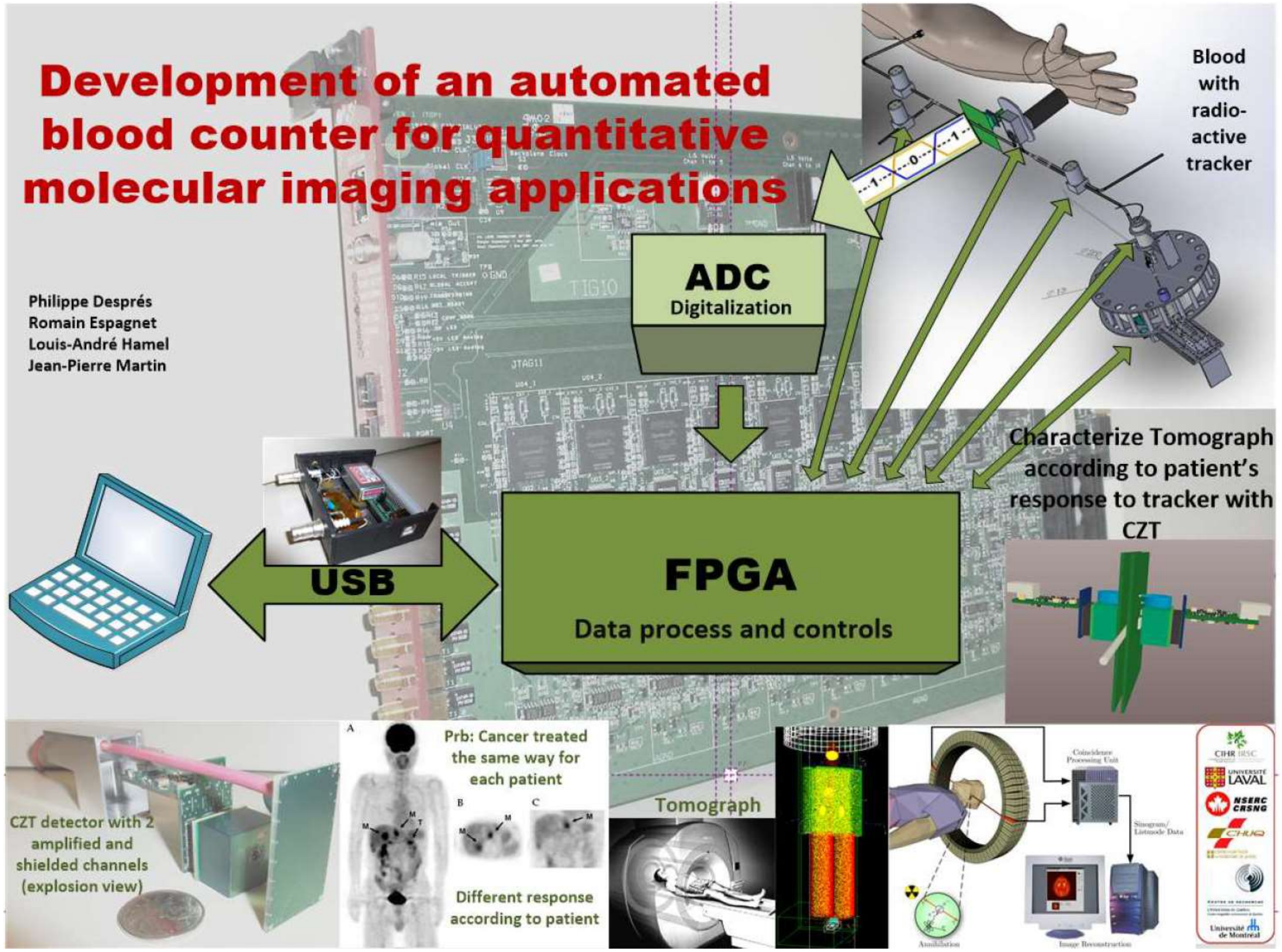
- Detector instrumentation:
  - 8π: gamma spectrometer DAQ system
  - OPAL: Z-chambers preamps and DAQ system
  - BaBar: Contribution to design and testing of the central detector readout ASIC.
  - TIGRESS: Design, fabrication and testing of the integrated TRIGGER/DAQ system
    - Based on 100 MS/sec. custom ADC cards with digital filters
  - GRIFFIN: Design of a data driven trigger system based on time-stamps
    - firmware in high-end FPGA
  - Belle-II:
    - Firmware to readout LISO radiation monitors at KEK (250 MS/sec. ADCs) synchronously with the beam rotations
    - HV control
  - CRIPT: Readout system (firmware) for the CRIPT detector (Cosmic muons imager)
  - ATLAS ITk upgrade: safety interlock system (~60 crates)
    - Design of the MON-FPGA cards
    - Firmware for MON-FPGA and collector back-end
  - X17 project: wire chamber preamplifier system and trigger/DAQ


LE GROUPE TECHNOLOGIQUE
(EARLIER PROJECTS)
J.-P. MARTIN, Y. LANDRY-DUCHARME, N. STARINSKI
Université de Montréal
CRIPT
Cosmic muon imagery
(PMT Readout System)
ATLAS
(Pixel Test Bench)
ANS Technologies
(Industrial support)
CZT
(System)
DESCANT
(1 GHz Digitizer)
DEuterated
SCintillator
Array for
Neutron
Tagging
SHARC
(50 MHz Digitizer)
Silicon
Highly-segmented
Array for
Reactions and
Coulex
TIGRESS
γ-Spectroscopy
(DAQ)
TRIUMF-ISAC
Gamma-Ray
Escape
Suppressed
Spectrometer
ALPHA,
TACTIC,
PiENu,
LXe
$\pi^+ \rightarrow e^+\nu / \pi^+ \rightarrow \mu^+\nu$
TRIUMF
Annular
Chamber for
Tracking and
Identification of
Charged Particles
PICASSO
(DAQ,
Detector
Container,
Sensors)
SuperB
(Preamps)

Conclusion

- UofM "Groupe Technologique" (GT):
  - Highly experimented scientists
  - Diversified skills
  - Well prepared for new challenges

spares


Development of an automated blood counter for quantitative molecular imaging applications
Philippe Després
Romain Espagnet
Louis-André Hamel
Jean-Pierre Martin
Blood with radio-active tracker
ADC
Digitalization
USB
FPGA
Data process and controls
Characterize Tomograph according to patient's response to tracker with CZT
CZT detector with 2 amplified and shielded channels (explosion view)
Prb: Cancer treated the same way for each patient
Different response according to patient
Tomograph

Investigation of Liquid Xenon Detectors for PET: Simultaneous Reconstruction of Light and Charge Signals from 511 keV Photons

P. Amaudruz[1], D. Bryman[2], L. Kurchaninov[1], P. Lu[3], C. Marshall[1], J. P. Martin[3], A. Muennich[1], F. Retiere[1], A. Sher[1]
[1]TRIUMF, 4004 Wesbrook Mall, Vancouver, BC, V6T 2A3
[2]University of British Columbia, 2329 West Mall Vancouver, BC Canada V6T 1Z4
[3]University of Montreal, Montreal, PQ, Canada

Introduction

This work is aimed at studying the interactions of 511 keV photons in liquid xenon (LXe) detectors for applications to positron emission tomography (PET). The advantages of LXe for PET compared to crystals include improved energy resolution, sub-mm spatial resolution, and larger detector volumes with high sensitivity. Figure 1 shows the concept of a LXe microPET scanner. Using a small test chamber we measured scintillation light and ionization charge signals in order to study the energy resolution in LXe.

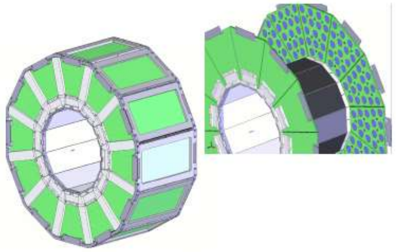
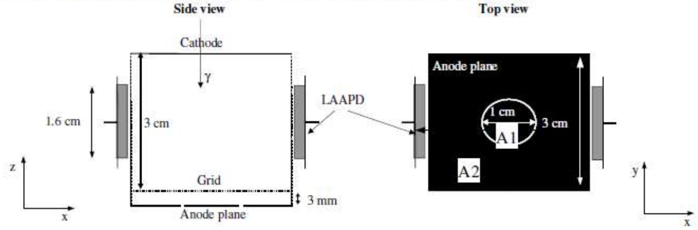


Figure 1. The LXe PET ring concept. Scintillation light and charge are measured in each of the 12 modules consisting of a LXe time projection chamber viewed by avalanche photodiodes.

The Test Chamber

A small test chamber (27 cm^3) was constructed to measure light and charge signals. An electric drift field was applied between the cathode and the shielding grid located near the anode charge collection plane as shown in fig. 2. Two large area avalanche photodiodes (LAAPD from API) were used to detect the scintillation light. Charge was collected on a central 1 cm dia. electrode (A1) or on an outer electrode (A2). The 511 keV photons emitted by a ^{22}Na source entered the test chamber (along the z axis) through the cathode plane and coincidences with an external NaI detector were studied.



Energy Resolution

To study the energy resolution we focused on the central region of the test chamber (A1 at z=1.5 cm from the cathode). Figure 4 shows the energy distributions observed for charge, light and the combination of both. The 511 keV region ellipse of the charge-light anti-correlation was fit and projected along the ellipse axis. Combining the information of the light and charge measurements, energy resolution (rms) as low as 3.78% was achieved as given in Table 2. An analysis of the contributing sources of errors is given in the Appendix below.

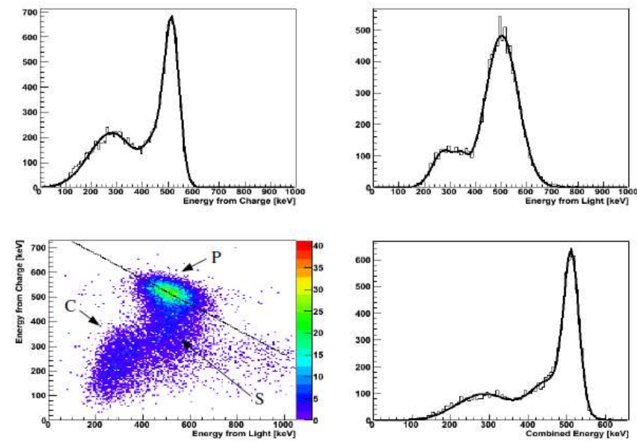


Figure 4. The observed charge spectrum (upper left plot), light spectrum (upper right plot), correlation between light and charge signals (lower left plot), and combined spectrum using the correlation (lower right plot) for 511 keV photons with a drift field of 2.66 kV/cm. The data points in the correlation plot that are not part of the Compton (C) or the photoelectric peak (P) are due to photons that scattered outside the detector (S).

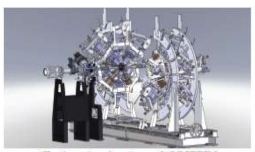
Future Opportunities with GRIFFIN

A.B. Garnsworthy, G.C. Ball, D. Bishop, D. Brennan, B. Davids, G. Hackman, R. Kruecken, C. Lim, C.A. Ohlmann, C.J. Pearson, *TRIUMF, Vancouver, Canada*; P.E. Garrett, E.T. Rand, C.E. Svensson, *University of Guelph, Guelph, Canada;* J-P. Martin, *Universite de Montreal, Montreal, Canada;* C. Andreoiu, K. Starosta, P. Voss, J. Williams, *Simon Fraser University, Burnaby, Canada*

Overview

Gamma-Ray Infrastructure for Fundamental Investigations of Nuclei (GRIFFIN) will be a new facility for decay spectroscopy at TRIUMF-ISAC, Canada's ISOL facility for radioactive beams. GRIFFIN will consist of an array of sixteen large-volume HPGe clover detectors with a total singles gamma-ray efficiency of 17% at 1.3MeV.

GRIFFIN will be installed during 2014 and will be fully operational in 2015.



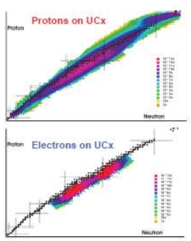
Engineering drawings of GRIFFIN

The GRIFFIN Spectrometer is being constructed as a collaboration between scientists at TRIUMF, University of Guelph, Simon Fraser University and the Universite de Monreal to create a state-of-the-art facility for decay spectroscopy with radioactive ion beams produced at TRIUMF-ISAC and the future ARIEL facility.

Nuclear Structure

The 8pi, and in the future GRIFFIN, couple to the TRIUMF-ISAC facility which produces radioactive beams through spallation of heavy targets using up to 100μA of 500MeV protons. The future ARIEL facility will also produce intense beams from photo-fission of actinide targets using an electron Linac driver.

The nuclear structure program at TRIUMF has focused around two main themes; very high statistics investigations of near-stability nuclei to observe very weak transitions, and studying the most neutron-rich nuclei that can be extracted from ISOL targets. These two themes will continue with GRIFFIN where the increased efficiency and through-put will push the limits well beyond what has been possible to date.



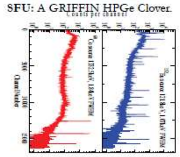
Anticipated Yields from the ARIEL Facility

Fundamental Symmetries

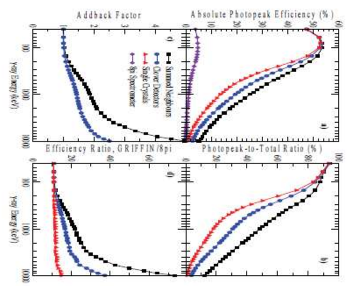
Detectors of GRIFFIN

SFU: A GRIFFIN HPGe Clover.

GRIFFIN will comprise of an array of 16 HPGe clover detectors in a close-packed configuration. The first two GRIFFIN Clover detectors are undergoing acceptance testing at Simon Fraser University.

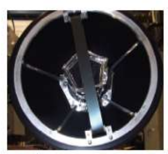


SFU: Measurement of the energy resolution of the HPGe.



GEANT4: Simulated performance of the full GRIFFIN array.

GRIFFIN will take advantage of all the ancillary detector sub-systems developed for the 8pi spectrometer. In addition the DESCANT array of deuterated-scintillators can be used in conjunction with GRIFFIN to study beta-delayed neutron decay.



SCEPTAR: 20 plastic scintillating paddles for beta coincidence tagging covering 80% of the solid angle.

DANTE: Eight Compton-Suppressed $LaBr_3$(Ce) detectors of 3"x3" size for fast timing of gamma-rays.

Digital Data Acquisition System

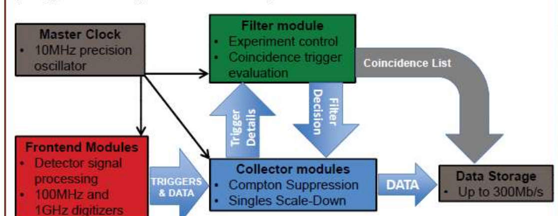
A custom-designed digital data acquisition system is being developed at TRIUMF and the Universite de Montreal. Detector signals will be digitized in 100MHz and 1GHz front-end modules and the data pushed up to filtering algorithms running on the FPGAs of 'Collector' cards. Filtered data will be written to disk at data rates up to 300Mb/s.

Left: GRIF-16 is based on TIG10 design. **Centre:** GRIF-4G Prototype. **Right:** GRIF-C Prototype.

GRIF-16 VME Module
100MHz, 14 bit, 16 channels
Process HPGe, BGO, Si(Li) signals, $LaBr_3$ TACs

GRIF-4G VME Module
1GHz, 12 bit, 4 channels
Process Beta scintillators, DESCANT scintillators (Energy and neutron-gamma discrimination)

GRIF-C VME Module
2GB RAM with peak transfer of 8.5Gb/s.
Link to each Frontend card of 650MB/s.
Data coincidence and filter decisions
Write data to disk



GRIFFIN DAQ: Conceptual overview of the GRIFFIN DAQ system.

In different experiments the GRIFFIN science program requires two demanding performance criteria from the DAQ system:

- A sustained data rate of up to 300Mb/s in order to observe very weak decay branches or